Deadlock and Livelock Solutions

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Deadlock

- Explain what is meant by deadlock
  - A thread is deadlocked when it cannot run
- Give an example of how deadlock can occur
  - Thread A acquires a lock on mutex 1 and waits for a lock on mutex 2
  - Thread B acquires a lock on mutex 2 and waits for a lock on mutex 1
- Suggest two ways to avoid deadlock
  - Always acquire locks in the same order
  - Use library features which can acquire multiple locks in a single operation

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Deadlock

- Write a program which causes two threads to deadlock
- Implement your solutions. Verify that the program is no longer affected by deadlock

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Deadlock avoidance (contd)

- In the following code, why are the unique_lock objects needed when the mutexes are already locked?

```
lock(mutex1, mutex2);
unique_lock<mutex> lk1(mutex1, std::adopt_lock);
unique_lock<mutex> lk2(mutex2, std::adopt_lock);
```

  - To ensure that the mutexes are always unlocked when leaving the enclosing scope
- Rewrite the solution to use unique_lock objects with the defer_lock option

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Livelock

- What is meant by the term livelock? How does it differ from deadlock?
  - A thread is livelocked when it is able to run, but cannot make any progress
  - In deadlock, the thread cannot run at all
- Briefly describe a situation where livelock can occur
  - Livelock can occur when trying to avoid deadlock
  - Instead of blocking indefinitely when they cannot get a lock, threads wait and retry
  - If the lock is not available, the threads will retry indefinitely
  - The threads are able to run, but cannot make any progress

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Livelock

- Write a program which demonstrates livelock
- Suggest how livelock could be avoided in your program
  - Use lock() to acquire both locks in a single operation
- Reimplement your program so it is not affected by livelock

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